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Method for soldering electrical connector pins on a support

The present invention relates to the field of soldering and in particular the soldering of connector pins on printed circuit boards.

To solder electronic components on a printed circuit board, various methods may be used such as soldering by conduction by means of a soldering iron or a wired robot. However, the quality of the result depends directly on the operator, and the cycle time is long. Selective wave soldering may also be used allowing a satisfactory cycle time, but the product being oriented downward during assembly constitutes a major constraint. Laser soldering may also be used. However, as the solders are made one after the other, the cycle time is long, in addition the investment is high.

Also known is the technique of soldering by hot gas nozzle. This technique combines several advantages relative to the other techniques. It allows a short cycle time; it leads to a reasonable investment, and is easy to implement. One method consists, for example, of installing the pins or pads of the components in their housing on the board, sliding a soldering disk onto each of the pins, placing a nozzle around a group of pins perpendicularly to the board and blowing air sufficiently hot to melt the solder around each pin. The nozzle is shaped so as to make a heating enclosure enveloping the group of pins. It comprises a free edge at the end of the gas guidance channel which is placed resting against the substrate. A space is retained for the gases to escape. The hot gas flow is thus first directed perpendicularly to the board in the direction of the pins to be soldered. After having blown over the pins and the solder, it is discharged via the escape

space made between the free edge of the nozzle and the surface of the board.

The departing flow is thus oriented parallel to the surface of the board. It is still sufficiently hot, in certain cases, to unsolder the adjacent components by melting their solder.

A problem arises in particular when soldering components on a board that is connected to a cold sink. This situation occurs, for example, when soldering connection components on a control circuit board, when they are themselves already connected to a board supporting power electronic components. The latter is designed to discharge the heat produced by the electronic components that it supports. It is for example a board of the IMS (Insulated Metal Substrate) type. The result is that the connection elements, that are fixedly attached to the IMS board at one end, discharge, via the heat sink that the power circuit board forms, the heat applied at the opposite end of the connection elements. In this case, to solder the end of the connection elements on the control circuit board, a greater quantity of heat must be provided than that necessary to solder a simple electronic component on a control circuit board.

If the user desires to use a soldering technique by hot gas nozzle in this context, he needs to use a gas taken to a relatively high temperature. Specifically, the temperature of the solder, situated on the opposite side of the plate forming the control circuit board, must be sufficient to achieve a melt and make satisfactory mechanical and electrical connections.

However, the hot gas escaping from the nozzle then remains at a sufficient temperature to unsolder the components situated nearby.

The applicant has set itself the objective of perfecting a method which makes it possible to use a gas at a high temperature for the soldering of components on a board without the gases disrupting the adjacent components.

The applicant has also set itself the objective of a method which provides an optimal circulation of the gaseous flows through the elements to be soldered so as to reduce the soldering time.

According to the invention, the method of assembling components comprising electric connector pins on a substrate in the form of a board, consisting of inserting the pins into individual housings via a first face of the substrate, the pins forming at least one comb-like alignment on the second face, arranging the solder on the second face of the substrate around the pins and heating the comb by means of a hot gaseous flow to achieve the soldering, is characterized in that the gaseous flow is guided so that it passes at least partially between the pins forming the comb from one side of the comb then, after it has passed through the comb, it is diverted away from the substrate. In particular the gaseous flow is diverted perpendicularly to the substrate after it has passed through the comb.

By diverting the gas flow leaving the zone so that it travels away from the substrate board, the temperature can thus be increased and a sufficient quantity of heat provided even in the presence of a heat sink.

According to another feature, the incident gaseous flow is perpendicular to the substrate and is diverted by the latter before passing through the comb.

Advantageously, the gaseous flow is guided by means of a hot gas nozzle comprising at least one wall of a length adapted to the length of the comb and a

deflector oriented parallel to said wall and distant from the latter so as to divert the gaseous flow leaving the comb without causing any major pressure loss. Preferably, the deflector of the nozzle is parallel to the wall.

According to a particularly advantageous feature of the method, the wall is placed in line with the comb so that the majority of the incident gaseous flow is guided through the comb. This placement of the wall is a simple way of guiding the incident flow so that it is used optimally.

The method has a particular value when the pins are elements of connection between a control circuit board and a power circuit board, the latter forming a heat sink.

A further subject of the invention is a nozzle for implementing the method. It comprises a channel for guiding a hot gaseous flow with at least a portion of rectilinear wall terminated by a free edge and an external baffle, parallel to the free edge. In particular, the deflector also extends parallel to the wall.

In order to make the heat exchanges between the gaseous flow and the pins to be soldered the most effective possible, the cross section of passage of the gas between the free edge and the deflector is substantially equal to the cross section of passage of the gas in said channel. The loss of pressure is thus as little as possible.

According to a particular embodiment, the nozzle comprises at least a second wall with a second deflector for the soldering of pins forming two combs parallel to one another.

Other features and advantages of the method will appear on reading the following detailed description, with reference to the appended drawings in which

figure 1 represents a view in section of an assembly between a power circuit board and a control circuit board,

figure 2 represents a view in longitudinal section of a nozzle applying the invention,

figure 3 represents a view in section in the direction III-III of figure 2,

figure 4 represents another embodiment of the nozzle according to the invention.

The control unit of an electropump module, for example, in a motor vehicle comprises a board supporting electronic power components connected to its control circuit board by connection elements. In figure 1, the power circuit board 10 of the IMS type comprises a substrate 11 on which the electronic components are mounted. The substrate is associated with a metal plate 13 through which the heat generated by the components is discharged. The plate is itself in thermal contact with the casing 15 of the module which is also metal to allow the heat to be discharged toward the outside of the unit. For example, the wall of the casing has a thickness of 5 mm and that of the metal plate 13 is 1.6 mm. The board 20 supporting the electronic control components is mounted in the casing at a distance from the board 10. The electric connection between the components of the two boards is provided by means of connection elements 30.

When the assembly is put together, the board 10 is first placed with its components in the bottom of the casing 15 and then the connector elements 30 are soldered onto the board. These elements are made of a conductive material and designed so as to be able to deform and reduce the internal mechanical stresses

resulting from the expansion of the pieces constituting the unit. The elements 30 include a pin 31 pointing perpendicularly relative to the board 10. Then the control circuit board 20 is put in place in its housing above the first board 10. The board 20 is conveniently pierced with orifices 22 allowing the pins 31 to pass through the first face 20_1 of the board, the face opposite the board 10. The pins 31 emerge from the orifices 22 on the second face 20_2 of the board 20 to present a part 31_1 protruding from the second face 20_2. The problem that the invention aims in particular to solve relates to the soldering of the pins on the board 20 by means of a hot gas flow.

The solder, for example made of tin-lead, is provided in the form of a ring, not shown, that is slipped over each pin 31. The assembly is heated to a sufficient temperature for the solder to run by capillary action between the pin and the walls of the orifice 22 in which it is housed. For the connection between the pin and the board to be satisfactory, the solder must form a fillet of solder at each of the faces of the board 20. The difficulty here is to obtain the formation of such a fillet of solder on the first face of the board.

As has been reported above, the heat sink constituted by the assembly formed by the two metal pieces 15 and 13 creates a heat gradient along the connection element. It is estimated at 12°C per millimeter. A preheating of the heat sink to 80°C would slightly reduce the gradient value to 10°C per millimeter. Thus, the conditions that exist require the application of a hot gas at a relatively high temperature. The temperature of the pin should be taken to 250°C so that, on the side of the first face 20_1, the temperature reaches the required value of 220°C. The hot gas, by blowing over the surface 20_2 of the board would disrupt the solders already formed.

Figures 2 and 3 show an embodiment of the invention making it possible to solve this problem.

The board 20 is traversed by two rows of pins 31 forming respectively two combs 31A and 31B. In this example, the comb 31A comprises five pins and the comb 31B comprises four pins. A nozzle 1 has been placed on these two combs in line with the pins. The nozzle comprises a tubular element 2, forming a column for guiding the hot gas flow in the direction of the board supporting the pins. The tubular element 2 is connected by a connection element to a source of hot gas not shown. The tubular element here has a trapezoidal cross section with two first walls 2A and 2B parallel with one another and two other walls 2C and 2D forming the trapezium. The shape of the element is determined by the placement and the number of the pins to be soldered. The distance separating the two walls is preferably equal to half the distance separating the two combs 31A and 31B, but it may also be greater. The length of the walls 2A and 2B is sufficient so that, as is seen in figure 3, they can be placed so as to envelope the two combs 31A and 31B.

When the spacing of the two walls 2A and 2B is equal to that of the two combs, their free edge 2A' and 2B' is level with the tops of the pins. The nozzle also comprises walls 3A and 3B, external to the column 2 and parallel to the free edges 2A' and 2B' respectively. These walls 3A and 3B forming deflectors rest by an edge 3A' and 3B' on the substrate 20. Preferably, the deflectors also extend parallel to the walls 2A and 2B. As can be seen in figure 3, the deflectors 3A and 3B are connected to the walls 2A and 2B by walls 3C and 3D extending the walls 2C and 2D respectively.

To solder the two combs 31A and 31B, the solder is placed in the form of rings, for example, on the pins, and the nozzle is placed as shown in figures 2 and 3.

The nozzle is rested by the free edges 3A' and 3B' on the substrate 20. In this position, the free edge 2A' and 2B' of the walls 2A and 2B is in line with the two combs. The difference in level between the free edges of the deflectors and of the walls is such that the distance separating the free edges 2A' and 2B' from the tops of the pins is small. Action is taken to ensure that it is as small as possible given the mechanical stresses. Contact between them must be avoided. The distance may thus be 5/10 mm. The nozzle is supplied with sufficiently hot gas for the solder B to melt and infiltrate by gravity and capillary action into the orifices 22. The gas is guided by the nozzle 2 in the direction of the board 20 and is diverted at 90°. It passes through the combs parallel to the surface of the board and is then diverted again at 90° on encountering the deflectors 3A and 3B. This gas flow is thus directed vertically without coming into contact with any components adjacent to the two combs 31. An escape flow that is slight in volume and velocity passes into the space that remains between the free edges 3A' and 3B' and the substrate 20. The nozzle is fashioned so that the clearance made is as small as possible. For example, a clearance of the order of 15/100 mm is acceptable. The gas used for heating may be air, nitrogen, argon or helium.

Thanks to the placement of the walls 2A and 2B in line with the combs with a small gap, the majority of the incoming hot gas flow is certain to be directed into the space between the combs and pass through them for maximum efficiency. Only a small quantity passes between the top of the pins and the free edge of the walls 2A and 2B. In this way, the energy of the gaseous flow is used optimally for a reduced soldering time. The cycle time obtained has been one second per pin.

Furthermore, the volume of leakage parallel to the surface of the board is, thanks to the deflectors, also

reduced. The result of this is a diminished risk of damage to the solders of the adjacent components.

Figure 4 shows another exemplary embodiment of the invention. In this case, a single row of pins has to be soldered. The nozzle is then formed of a single wall 102A with a single deflector 103A. As in the previous embodiment, the wall is arranged so that its free edge 102A' comes in line with the top of the pins with a slight clearance when the nozzle is resting on the free edge 103A' of the deflector. The deflector guides the flow from the comb at 180° preferably, relative to the incident flow. The angle may be smaller but always greater than 90°. The free edge 102B' of the wall 102B forming the column is at the same level as the free edge 103A' in order to reduce the volumes of leakage on that side.